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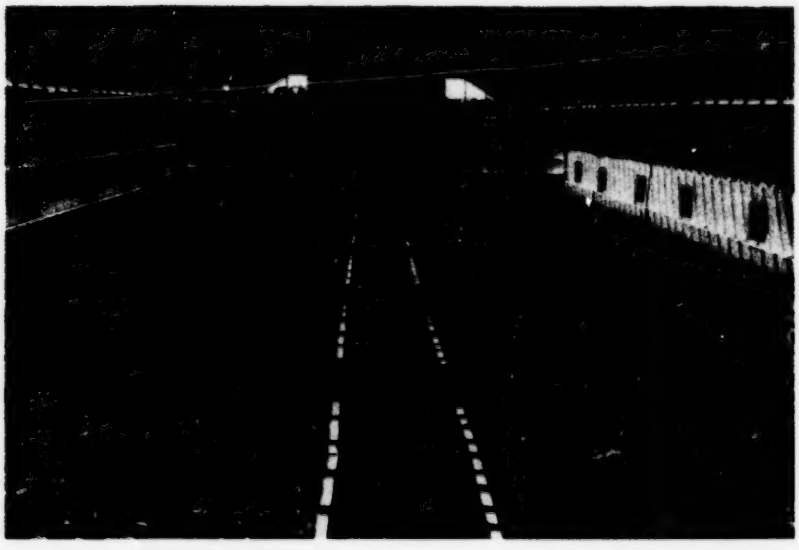
1982

TOBACCO PRODUCTION RECOMMENDATIONS



Ontario

Ministry of Agriculture and Food

Duncan M. Allan
Deputy Minister

Hon. Lorne C. Henderson
Minister

All information and recommendations contained in this publication relating to the use of pesticides have been reviewed by the Ontario Pesticides Advisory Committee.

EMERGENCY PROCEDURE FOR PESTICIDE POISONING

If a person suspects poisoning from exposure to a pesticide by swallowing, inhalation, or contact with skin or eyes, read the label on the pesticide container and carry out the first-aid treatment suggested.

If a pesticide has come in contact with the skin or has been spilled on clothing, remove the clothing and wash the skin thoroughly with soap and warm water.

If a pesticide has come in contact with the eyes, rinse them with plenty of water for 15 minutes.

IMMEDIATELY AFTER THE FIRST-AID TREATMENT HAS BEEN GIVEN, WRAP THE PATIENT IN A COAT OR BLANKET AND RUSH HIM TO THE NEAREST HOSPITAL, TAKING THE LABELLED PESTICIDE CONTAINER WITH YOU.

First-aid Information The Occupational Health and Safety Division, Ministry of Labour, 400 University Ave., Toronto, M7A 1T7, has physicians available for consultation on first-aid information and advice. They can be contacted in the following manner:

Between the hours of 8:00 a.m. and 5:00 p.m. Monday to Friday, telephone — **(416) 965-3610**

During weekends, public holidays and non-office hours telephone — **(416) 965-1211** and ask for the "on-call" physician.

The recommendations in this publication are for the 1982 season and may be revised whenever further information is available. **Discard old editions.**

All recommendations in this publication are stated in metric units. Amounts of materials recommended for field application are for one hectare (ha) while greenhouse treatments are expressed in amounts per 100 square metres (100 m^2). Refer to pages 21, 22 and 23, for conversion factors and metric equivalents.

Assistance with problems regarding tobacco production may be obtained by contacting:

(a) Burley Tobacco
Clem Fisher, Research Station, Harrow, N0R 1G0
(519) 738-2251

(b) Flue-Cured Tobacco
Norm Sheidow, Research Station, Delhi, N4B 2W9
Milt Watson, (519) 582-1950

Agri-Phone — (519) 582-1713

The Ontario Ministry of Agriculture and Food maintains an Agri-phone at the Research Station, Delhi. Agri-phone messages, updated three times a week, are available throughout the growing season.

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PRECAUTIONS WITH PESTICIDES

1. Always read the label before opening pesticide containers, and follow all precautions and directions.
2. Never smoke, chew tobacco or eat while handling or applying pesticides. DO NOT carry such items in clothes used for spraying.
3. Always wear neoprene gloves to handle the concentrate. Wear a mask to reduce pesticide inhalation, especially when handling dusty formulations or volatile concentrates. Avoid inhaling spray droplets, dust or fumes by wearing a mask.
4. Avoid spilling pesticides on skin or clothing.
5. Wear freshly laundered clothes each day.
6. When filling or flushing spray equipment, avoid contamination with pesticides of water supplies, wells, ponds, streams, etc. Never fill a sprayer directly from a stream or pond, unless the unit is equipped with an anti-backflow device to prevent siphoning.

IF ACCIDENTS OCCUR

1. If an accident occurs, remove contaminated clothing immediately, and wash contaminated skin thoroughly with soap and water. Wash clothing before reuse.
2. If clothing becomes wet with a pesticide when spraying, remove it immediately. When the spray operation is complete, remove contaminated clothes, have a bath or shower and put on freshly laundered clothing.
3. Clean up any pesticide spills immediately. Use dry soil, sawdust or other absorbent material to remove excess liquid. If the spill is major, contact the nearest office of the Pesticide Control Service for advice. (see list page 24).
4. If symptoms of illness occur during or shortly after handling or applying a pesticide, get the patient to hospital immediately. If possible, take a labelled container of the presticide with you. (see **Emergency Procedures for Pesticide Poisoning**, Inside Front Cover).
5. If a well becomes contaminated, follow clean up instructions in factsheet *Pesticide Contamination of Farm Water Supplies* Order No. 80-025, Agdex 607, March, 1980.

SPECIAL INSTRUCTIONS

It should be emphasized that all pesticides are toxic and must be handled safely. In addition, a number of pesticides (insecticides, fungicides and herbicides) have major deficiencies in their toxicological information because of the many tests that were conducted by the Industrial Biotest Laboratory (IBT), some of which were invalid. Replacement studies are currently being conducted by the respective registrants. Those handling and applying these chemicals must pay special attention to the precautions outlined above.

At the time of publication, pesticides included in *The 1982 Tobacco Production Recommendations* requiring additional studies are as follows:

CSA COMMON NAME	TRADE NAME
acephate	Orthene
captan	Captan, Orthocide
diazinon	Basudin
oxydemeton-methyl	Metasystox-R

STORAGE

1. Keep pesticides out of the reach of children, irresponsible persons, pets, and livestock. Store them away from the home, food, and feed and keep the room locked. Post pesticide storage area notices.
2. Always store pesticides in original containers and keep them tightly closed. Never put pesticides in unmarked containers.

DISPOSAL OF PESTICIDE CONTAINERS AND CONTAMINATED MATERIAL

1. Containers from pesticide packages and any paper or other material used to clean up spills should be buried or burned. Make sure that people and animals are kept away from the smoke and that the smoke is not directed toward buildings, highways, roads, or outdoor areas frequented by the public.
2. Rinse all empty metal or glass containers three times with water, add washings to the spray tank. Dispose of the containers by puncturing or breaking and burying the container in such a manner that it is covered by at least 50 cm of soil and is not near any water-course or water table.

PROTECTIVE CLOTHING WHEN USING PESTICIDES OUTDOORS

1. When measuring and mixing pesticides, wear neoprene or rubber gloves, rubber boots, a protective apron or coveralls, and protective eyeshields. (Inexpensive disposable aprons, shirts, pants, and headwear are also now available.)
2. Wash all protective clothing after use.
3. Wear a chemical cartridge respirator with a dual chemical cartridge when mixing or applying pesticides. The following respirators are recommended for outside use against light pesticide concentrations:

   WILLSON AGRI-TOX 2 Respirator with R21 cartridge and R15 filters
   NORTON 7549 or 7649 Respirator with 7500-21 cartridges and 7500-23 filters
   MSA 448848 or 460560 Respirator with 464025 combination cartridges
   AMERICAN OPTICAL R4058, R5058 or R6058 Respirator with R50 filter/cartridges
   PULMOSAN 241 Respirator with 241-7 filter/ cartridges

SAFETY HOUSE OF CANADA 236-G100-F104 Respirator with G100 cartridges and F104 filters
H. S. COVER 1482 Respirator with 100 cartridges and 104 filters

They should always be worn when applying pesticides listed in the "extremely toxic" or "highly toxic" categories in this publication. Change cartridges according to manufacturer's directions.

A powered chemical cartridge respirator, W-262 GENERAL PURPOSE SYSTEM, is now available from the 3M Company, and is suitable for vehicle mounting.

Complete information on protective equipment may be found in *Personal Protective Equipment for Pesticide Users*, available at offices of the Pesticide Control Service, your pesticide dealer, and offices of the Ontario Ministry of Agriculture and Food.

PROTECTIVE CLOTHING WHEN USING PESTICIDES IN GREENHOUSES AND OTHER ENCLOSED AREAS

1. When measuring and mixing pesticides wear neoprene or rubber gloves, rubber boots, a protective apron or coveralls, and protective eyeshields unless a full-face gas mask is being used.
2. When the label calls for a full-face gas mask, use it. Use the correct canister.
3. Gas masks should fit tightly. Check by inhaling deeply after closing off the air intake. The mask should feel tight around the face. After use, remove the canister and wash the mask carefully with soap and water, rinse well, and dry carefully before storing in a clean, dry place.
4. When extremely toxic or highly toxic pesticides are being mixed or handled, a chemical cartridge respirator with a dual cartridge should be worn.
5. When applying extremely toxic or highly toxic pesticides indoors, a full-face gas mask with correct canister should be used. Keep a fresh canister on hand as they lose their effectiveness after a certain period of time. For methyl bromide a special canister is required. A self-contained breathing apparatus, eg. SCOTT AIR-PAC is recommended for greenhouse work when using gases or extremely toxic compounds.

(a) *Dusting* Wear a good respirator or a full-face mask when the label calls for it.

(b) *Fogging Machines* Wear complete protective clothing including a hat, jacket or pants or coveralls, rubber gloves, and an air-tight, full-face mask.

(c) *Smoke Bomb* Wear a full-face mask when lighting the bombs and when aerating the house. Light the bomb farthest from the door and work toward the door. If bombs are placed in more than one path, more than one man should light them.

(d) *Soil Drenches* Pesticides used for this are highly toxic. Use neoprene or rubber gloves, rubber boots, coveralls, respirator, and protective eye equipment.

(e) *Spray Applications* Wear waterproof hat, jacket, and trousers (outside of boots), neoprene or rubber gloves, and an airtight full-face mask.

(f) *Granular Materials* Some granular materials like Temik 10G are extremely hazardous. Wear a respirator, water-resistant clothing, protective eye shields, neoprene or rubber gloves, rubber boots with trousers outside of boots. Keep all granules off skin. If contamination occurs, wash immediately with soap and water. After completing application, wash entire body. Never eat or smoke before washing hands well.

DISPOSABLE PLASTIC AND WATERPROOF CLOTHING

There are now available plastic aprons, disposable hoods, laboratory coats, boot covers, coveralls, protective female smocks, and hat covers at a reasonable price. A special two-piece coverall set for easy movement and comfort is also available.

Any of the above are available direct from TITAN Disposables Limited. 8530 Esplanade Ave., Montreal, P.Q. H2P 2R8. Telephone (514) 381-2301. Telephone or write for prices and further information.

Protective clothing is also available from many of the safety supply houses.

RELATIVE TOXICITIES OF PESTICIDES RECOMMENDED ON TOBACCO

Extremely toxic — Guthion (azinphos-methyl); Phosdrin (mevinphos); Lannate (methomyl).

These pesticides are dangerous if inhaled, swallowed, or allowed to contact skin. A few grams can be fatal. Wear protective clothing (page 3), avoid mixing in windy areas, dispose of containers properly (page 3) and always change clothing and wash immediately after use.

Moderately toxic — Allyl Alcohol; Basudin (diazinon); Diazinon; D-D; lindane; Lorsban (chlorpyrifos); Telone II; Telone C-17; Vorlex; Fair-Pik; Pirimor (pirimicarb); Terrocide 15-D; Vorlex-CP; Ripcord.

These pesticides are dangerous if handled carelessly. Caution is required to insure that they are not taken internally or allowed to contact skin. Wear protective clothing when mixing or working with them in confined areas. Avoid breathing the vapors. Remove clothing and wash after applying these pesticides. Dispose of containers properly (page 3).

Pesticides listed in this calendar and not appearing on this list have lower toxicities and should be handled with all precautions listed on the label. Even the most toxic pesticides can be used safely, if used properly, by following all directions and precautions listed on the label.

RE-ENTRY TO TREATED AREAS

Pesticide poisoning may occur where workers enter fields too soon after pesticides have been applied. Such poisoning can result from handling treated plants or from inhalation of pesticide vapors.

The pesticides listed below are those for which a specific minimum interval must be observed from the time of application to the time of working in the crop. For some pesticides, e.g., parathion, the label carries a warning regarding working in treated crops. *Follow these recommendations.* Where no label warnings are provided, minimum intervals recommended for reentry are *24 hours for* Lannate and *48 hours for* Phosdrin, Guthion and Metasystox-R.

PESTICIDE DRIFT

Pesticide drift can leave unwanted residues on adjacent crops, be a hazard to people and livestock nearby or reduce the amount of material in the target area as to be ineffective. Those applying pesticides should make every effort to minimize or prevent pesticide spray drift by paying attention to:

(1) correct calibration and maintenance of spray equipment;
(2) correct operation of the equipment;
(3) the toxicity of the pesticide in use; and
(4) the weather conditions.

For more information consult OMAF Factsheet *Pesticide Drift,* Agdex 607 or Canadex 607, *Pesticides: effects of drift and droplet size.*

APPLICATION BY AIRPLANE OR HELICOPTER

Aerial applicators must be licenced by the Ontario Ministry of the Environment to apply pesticides. In addition, permits are required from the Ontario Ministry of the Environment under the authority of the Pesticides Act 1973 for the application of Schedule 1 and 5 pesticides and Schedule 2 hormone-type herbicides. The area will be inspected by Ministry personnel to ensure safety of application.

It is an offence under the Federal Pest Control Product Act to use a control product under unsafe conditions. Precautionary practices must be heeded at all times to prevent drift. Extra precautions should be taken when using insecticides applied by air, especially those known to be toxic to honeybees, eg Sevin (carbaryl).

Applications should not be made if the wind is blowing. Some drift occurs even on the stillest day and to keep it to a minimum, apply pesticides in the evening or early morning.

Be sure that the product to be used is specified, along with rate of application, in the contract.

In this publication most recommendations list several pesticides that are effective for each insect or disease discussed. Where possible, the less hazardous materials and those that growers have used satisfactorily for a number of years are listed first. These are followed by the toxic pesticides and/or newer ones with which we have less experience. It must be emphasized that in some cases the most effective pesticides are highly toxic.

The effectiveness of pesticides, and plant injury by control chemicals, are influenced by the weather and other conditions. Consult the package label and other information regarding compatibility with other materials, the effect of high or low temperatures, poor drying conditions, etc. Wettable or soluble powder (WP and SP) preparations generally are less likely to cause plant injury than liquid concentrate (EC, SC, and F) formulations.

PESTICIDE RESISTANCE

Many of the pesticides recommended have a very specific mechanism of action, that is, they act on a single system or site in the organism. These materials should not be used continuously and repeatedly in a season-long program since this will increase the chances of the development of pest resistance. An example of this type of compound is Benlate.

In our recommendations we suggest that such compounds be used in combination with other pesticides or that they be alternated with other pesticides so that the likelihood of resistance development is reduced.

ABBREVIATIONS

EC	= emulsifiable concentrate	kg	= kilogram
SC	= spray concentrate	g	= gram
WP	= wettable powder	ha	= hectare
SP	= soluble powder	m	= metre
F	= flowable	cm	= centimetre
G	= granules	mm	= millimetre
°C	= degrees Celsius	L	= litre
%	= percent (by weight)		

All pesticide products are registered by Agriculture Canada. No pesticide may be used on any crop for which it is not registered. Such use can result in seizure of the crop.

PESTICIDE RESIDUES

To minimize or eliminate pesticide residue in cured tobacco:

(1) Observe the specified interval between foliar treatment and harvest as indicated in brackets following the recommendation.
(2) Do not apply more than the recommended amount.
(3) Do not apply more often than recommended on the label.

For example, Ambush 500 EC, 140 mL/ha (55 days) indicates that Ambush should not be used later than 55 days before the treated tobacco is harvested, and no more than 140 mL of the 500 EC formulation should be used for one hectare of crop in an application.

NOTE: Recommendations in this publication refer to both flue-cured and burley tobaccos unless otherwise indicated.

INSECT CONTROL

CUTWORMS

(a) **Greenhouse**

When damage appears, spray the plants in the evening with one of the following per 100 m^2 of seedbed area in 15 L of water:

Ripcord 40 EC — 3 mL (about ½ teaspoonful)
Ambush 500 EC — 2.5 mL (½ teaspoonful)
Dylox 80% SP — 45 g

(b) **Field**

Use one of the following three alternatives. Apply materials during late afternoon or in the evening using at least 220 L/ha of water. Cutworms may migrate to tobacco fields from bordering areas. Use Lorsban, Ambush or Ripcord to treat these areas according to label directions and precautions.

(1) Cover crop—
Lorsban 4C —1.5 L/ha
Ambush 500 EC —140 mL/ha
Ripcord 40 EC —90 mL/ha

Treatment of the cover crop is most effective when applied soon after the cutworms have hatched. Application can usually be made in mid-to-late-April. When the cover crop is 10-15 cm high the cutworms will be at the right stage for best control. Treat 4 to 5 days before plowing.

(2) Soil—
Lorsban 4C —3 to 6 L/ha
Ambush 500 EC —140 to 275 mL/ha
Ripcord 40 EC —175 to 350 mL/ha

These materials work best when the soil is moist. Use the higher rates when the top 2 cm or more of soil is dry. Treat 1 to 3 weeks before planting, and preferably before mid-May.

Do not incorporate these insecticides. The soil should not be disturbed for at least 5 days after applying Ambush and Ripcord since mixing with the soil will reduce the effectiveness of these materials. The activity of Lorsban may be reduced by deep incorporation.

(3) After Planting—
Ambush 500 EC —140 mL (55 days)
Ripcord 40 EC —175 mL/ha (60 days)
Orthene 75% SP—1.50 kg/ha (3 days)

This treatment may also be used if pre-planting treatments fail to provide control.

NOTE: For cutworm control late in the season, ie: during late June and July, use only Orthene because the treatment to harvest intervals established for Ambush (55 days) and Ripcord (60 days) permit use of these materials only during a short period of time after planting.

WIREWORMS

Use one of the following amounts of insecticide per 180 L of of planting water.

lindane 25% WP—28g
lindane 50% WP—14 g

Apply 170 mL of the mixture per plant. With 107 x 61 cm spacing, 2600 L/ha would be required.

Stir mixture frequently to reduce settling and drain the barrel occasionally to avoid over-concentration of the insecticide. Lindane may be used in combination with Basudin in the planting water.

SEED MAGGOTS

Well-hardened, sturdy transplants are less apt to be retarded by maggot feeding. Use one of the following per 180 L of planting water:

Basudin 50W or Diazinon 50W—42 g
Lorsban 25W —57 g

Apply 170 mL of the mixture per plant. With 197 x 61 cm spacing, 2600 L/ha would be required.

Stir the mixture frequently to reduce settling and drain barrel occasionally to prevent over-concentration of the insecticide. Basudin or Diazinon may be used with lindane in the planting water.

CAUTION: (1) Do not combine Lorsban with lindane in the planting water.
(2) Do not combine Basudin, Diazinon or Lorsban with starter fertilizer in the planting water.
(3) Band treatments of granular fertilizer should be placed 10 cm on each side of the tobacco row. Closer placement, in combination with Basudin, Diazinon or Lorsban in planting water, may injure tobacco plants.
(4) Avoid contact with planting water containing lindane, Basudin, Diazinon or Lorsban.

TARNISHED PLANT BUGS

Tarnished plant bugs occasionally infest tobacco fields during July. They feed on the leaves and injure the leaf midrib, causing the end of the leaf to wilt or break.

Use the following:
Dylox 80% SP—1.50 kg/ha (3 days)

HORNWORMS

Hornworm control is not economical unless the population averages 5 small larvae or more per 100 plants.

If the above population occurs, use one of the following in sufficient water to provide adequate coverage; repeat if necessary.

(1) Dipel, 275 g/ha (0 days)
(2) Thuricide HPC, 1 L/ha (0 days)
(3) Orthene 75% SP, 725 g/ha (3 days)
(4) Dylox 80% SP, 1.50 kg/ha (3 days)
(5) Sevin 50% WP, 2.25 kg; 80% WP, 1.50 kg; 85% WP, 1.25 kg/ha (3 days)
(6) Lannate Liquid, 2.25 L/ha (5 days). *Minimum period before entering fields treated with Lannate is 24 hours.*

Ground or aircraft applications are equally effective. Do not work in tobacco fields during application of chemical insecticides. Observe the recommended interval between treatment and harvest.

Tobacco treated with Thuricide HPC or Dipel can be handled immediately after treatment as these materials are not poisonous to man or animal.

NOTE: Hornworms stop eating immediately after feeding on tobacco treated with Thuricide HPC or Dipel. The larvae may remain alive but not feeding up to 6 days after treatment.

APHIDS

Seedbed

If aphids are present, use one of the following per 100 m^2 of bed at least 5 days before first plants are to be pulled; repeat if necessary.

Dust—malathion 4%, 500 g

OR

Spray—malathion 25% WP, 30 g per 12 L of water applied at 12 to 24 L, depending on size of plants.

Field

Treat especially the undersides of the leaves with one of the following:

(1) Pirimor 50W, 275 to 550 g/ha (14 days)
(2) Metasystox-R, 1.25 L/ha (14 days) (flue-cured only). *Minimum period before entering fields treated with Metasystox-R is 48 hours.*
(3) Orthene 75% SP, 725 g/ha (3 days)
(4) Lannate Liquid, 2.25 L/ha (5 days). *Minimum period before entering fields treated with Lannate is 24 hours.*
(5) Guthion 240 SC, 3.50 L/ha or 50% WP, 1.7 kg/ha (6 days). *Minimum period before entering fields treated with Guthion is 48 hours.*
(6) Malathion 50% EC, 2.00 L/ha (7 days)
(7) Phosdrin 100% liquid, 150 mL/ha (3 days). *Minimum period before entering fields treated with Phosdrin is 24 hours.*

NOTE: (1) Thorough spray coverage of the upper part of the plant, where aphids are normally found, is essential to obtaining good control. Follow label directions for nozzle arrangements and spray volumes.
(2) Malathion is not effective at temperatures below 18°C.
(3) Application of non-systemic insecticides by aircraft for aphid control may not be as effective as ground application because of inadequate underleaf coverage.

FLEA BEETLES

These small, shiny, black jumping beetles chew small holes in the lower leaves. If high populations are present, use one of the following:

Sevin 50% WP, 2.25 kg; 80% WP, 1.50 kg; 85% WP, 1.25 kg/ha (3 days).
Orthene 75% SP, 725 g/ha (3 days).

NOTE: These insects seldom cause sufficient damage to warrant treatment.

GRASSHOPPERS

Maintain weed-free borders and fencerows. If grasshoppers are a problem, spray around the edge of the tobacco field with one of the following:

(1) Sevin 50% WP	— 3.25 kg/ha (3 days)
80% or 85% WP	— 2.00 kg/ha (3 days)
(2) malathion 25% WP	— 3.25 kg/ha (7 days)
50% EC	— 1.75 L/ha (7 days)
(3) Basudin 50 W	— 1.10 kg/ha (14 days)
(4) Guthion 240 SC	— 1.10 to 1.75 L/ha (6 days). *Minimum period before entering fields treated with Guthion is 48 hours.*

NOTE: Malathion is not effective at temperatures below 18°C.

WARNING

Avoid inhaling pesticide dust or spray.

DISEASE CONTROL

For additional information on diseases affecting tobacco refer to Agriculture Canada Publication 1641, *Tobacco Diseases.*

SEEDBED STERILIZATION

Thorough sterilization is necessary to rid the seedbed of weeds, soilborne diseases and nematodes. Steaming is considered to be the most consistent and reliable method of sterilization, provided the soil is in proper condition and sufficient time is taken to obtain the required temperature.

Steaming may be done in the fall or spring. Conditions in the fall are likely to be more favorable for thorough steaming than in the spring when frozen soil is often a problem. Fall steaming also has the advantage of allowing time for the recovery of soil microorganisms, some of which may compete with damping-off fungi, reducing their spread and development. One disadvantage of steaming in the fall is the possible reinfestation of the seedbed with weedseeds and diseases due to glass breakage during the winter.

The usual method is to inject steam under a metal pan although large plastic sheets are being used in a few cases. To provide optimum conditions for steam penetration, the seedbed should be uniformly loose with just enough moisture for the germination of seeds.

For thorough sterilization with steam, a temperature of 82°C held for 30 minutes at a 15 cm depth is required. These requirements will normally be met by steaming under pans for half an hour. Three to five hours may be required when plastic is used, depending mainly on soil condition, type of steamer, and size of plastic. A soil thermometer should be used to determine the required steaming time.

Disease organisms may be harbored on walls, walks, and boards in the greenhouse and may contaminate the sterilized seedbed. A formaldehyde solution (1 L of formalin to 25 L of water) applied to these areas after steaming, and 4 to 5 days before seeding, has proven effective in reducing seedling diseases, particularly those causing damping-off. It is preferable to apply the solution on a warm day. After the solution has been applied, the greenhouse should be closed for 2 days and then opened for at least 2 days before seeding, to allow injurious fumes to escape.

CAUTION: Avoid drenching areas of the seedbed with the formaldehyde solution. Damage to germination and seeding growth may occur where the seedbed is drenched with formaldehyde 4 to 5 days before seeding.

Chemical sterilants such as AA (allyl alcohol), Basamid, Mylone, and Vorlex, have usually provided acceptable weed control when applied according to manufacturer's directions. However, these materials have been inconsistent in the control of black root rot, which can be a serious disease in the seedbed. There is a lack of information on the effectiveness of these materials for blue mold control in the seedbed. At present, thorough steaming seems to be the most reliable means of controlling these diseases.

DAMPING-OFF (BED ROT)

Damping-off is caused by organisms (mainly Rhizoctonia and partly Pythium) present in most soils. It may affect very young seedlings just as they are emerging, causing the plants to shrivel and die. Later occurrence of the same disease may be indicated by a wet rot which develops where plant stems and leaves decay at the ground surface. The disease is often found in patches throughout the seedbed, and is usually most serious where there is a thick stand of plants. In most cases recontamination of the sterilized seedbed is the main cause of the disease. Conditions such as humid atmosphere, wet seedbed soil, and thick stands of seedlings, favor development of damping-off.

Control

The prevention or control of damping-off depends on a combination of good greenhouse management and the proper use of fungicides. Apply one of the following per 100 m^2 when damping-off first appears:

(1) Benlate 50W at 125 g in 250 to 350 L of water. Repeat if necessary.
(2) Captan 50 WP or Orthocide 50 at 250 g in 200 L of water. Repeat if necessary in 10 to 14 days.
(3) Benlate 50 W at 125 g and Captan 50 WP or Orthocide 50 at 250 g as a tank mix in 250 to 350 L of water.

NOTE: Benlate provides good control of the more common Rhizoctonia type of damping-off but is ineffective against Pythium. Captan, although less effective than Benlate on Rhizoctonia, is effective in controlling Pythium.

The following management procedures will help in the prevention and control of damping-off:

(1) Before sterilizing, loosen the seedbed to promote good drainage.
(2) Thoroughly sterilize the soil.
(3) Surface sterilize shoes and tools before walking and working in a sterilized seedbed. Use a formaldehyde solution mixed 1 to 25, formalin to water.
(4) Treat walls and walkways with a formaldehyde solution. (See page 7 under **Seedbed Sterilization**.)
(5) Use the recommended seeding rates.
(6) After the plants cover the seedbed, do not water in the afternoon.
(7) Ventilate as much as possible.
(8) Aim to have the seedbed surface as dry as possible by evening.

BLACK ROOT ROT (Seedbed)

The disease is found where the soil has not been properly sterilized. Usually small areas of the seedbed are affected. Diseased plants transplanted to the field will be very slow to start growing.

Control

Thorough sterilization will control this disease in the seedbed. Avoid deep working of the seedbed after sterilization.

YELLOW PATCH

Characteristic symptoms of yellow patch are irregular patches of yellow, stunted plants in the seedbed. Roots of affected seedlings exhibit various degrees of discoloration and rotting. In severe cases affected seedlings die; in milder cases new rootlets develop above the rotted ones and the plants may recover.

Control

This trouble is caused mainly by excessive fertilization of the bed before sowing and can usually be prevented by following the fertilizer recommendations. If yellow patch develops, some relief can be obtained by allowing the soil to dry out thoroughly for about 2 days and then watering heavily to leach out some of the excess fertilizer. (See page 12, under **Seedbed Fertilization**) Excessive compaction of the seedbed soil tends to aggravate this condition.

2,4-D INJURY

Symptoms vary depending in the amount of 2,4-D to which the plants are exposed. Usually the most obvious symptom is extreme leaf distortion. Affected leaves droop, are narrow and often more or less strap-shaped, with very prominent veins and wavy or deeply-toothed margins and, in many cases, the surface is blistered. In mild cases the plants may recover, but in severe instances there is no recovery from the damage.

Control

Tobacco plants are very sensitive even to small amounts of 2,4-D. Any sprayer or other equipment that has been used for 2,4-D application should **never** be used on tobacco. Spraying with 2,4-D should not be done near tobacco beds or tobacco fields because there is always danger of spray or vapor drifting.

ATRAZINE DAMAGE

When this material is present in the seedbed, at or soon after seeding, plants will emerge but they soon dry up and disappear. When applied to larger plants in the seedbed, atrazine causes a yellowing of the leaves, especialiy the tips and margins and, depending on amount, death of the leaf or entire plant may occur.

Symptoms of Bladex and other triazine herbicides are similar to atrazine.

Control

Sprayers or parts of spray equipment that have been used to apply atrazine or other triazine herbicides should never be used to spray tobacco. Be careful not to contaminate water supplies and never fill the herbicide sprayer near the greenhouse.

BLUE MOLD

(a) **Seedbed** On small seedlings the first leaves lose their normal green color and a grey to bluish mold develops. Larger seedlings show a more pronounced yellowing and often wilt slightly. Affected seedlings are unsuitable for transplanting as they remain stunted and the brittle stems are easily broken by wind.

(b) **Field** Infected leaves initially show large yellow spots with greyish-blue mold on the undersurfaces. As these spots age they become brown and the dead tissue eventually drops out either in the field or during curing.

Control

Steam sterilization of the seedbed and treatment of the walls and walkways with a formaldehyde solution as described under **Seedbed Sterilization** are recommended to destroy any blue mold contamination in the greenhouse.

Preventive measures against blue mold were not finalized at the time of publication. Registered treatments for the greenhouse and field as approved by the Blue Mold Task Force will be recommended according to label directions.

FIELD STUNTING OF TOBACCO

Root lesion nematodes and black root rot are the main causes of stunting in Ontario. Occasionally a combination of both diseases may occur or a third factor, as yet undefined, may be involved.

Nematodes Nematodes are most likely to occur in sufficiently high populations to cause stunting on the well-drained medium to light tobacco soils. The main characteristic of nematode damage in the field is the appearance, in late June or early July, of patches of stunted plants which tend to wilt, particularly during mid-day. Root systems are usually quite small and brown areas may be seen on the roots. In severe cases, the plants remain stunted throughout the season, and the yield will be greatly reduced. In milder cases, the affected plants may recover by mid-summer, but such plants are late in maturing.

Black Root Rot This disease is more prevalent on the heavy or poorly-drained tobacco soils, and during cool wet seasons. Damage is usually more severe where there is crop sequence of tobacco following tobacco. Under severe conditions, plants are stunted early in the season, and their maturity is delayed, resulting in a reduction of yield and quality of tobacco. Crop losses are seldom high where varieties with high tolerance to black root rot are used.

A satisfactory crop rotation such as rye-tobacco or wheat-tobacco should be practiced to help prevent the buildup of black root rot in the soil. For flue-cured tobacco on heavy or poorly-drained soils, a corn-tobacco rotation may prove beneficial in reducing black root rot. Varieties are now available which have a high degree of tolerance to this disease. Of the flue-cured tobacco varieties, Delhi 76 Nordel and Delgold are the most tolerant, followed by Virginia 115 and Newdel, (pages 17 and 18). The burley varieties, Burley 1 and Harwin, have shown tolerance to the disease.

Control

Several soil fumigants are available to control nematodes and aid in reducing damage from black root rot. These materials must be injected into the soil 15 to 30 cm deep in the spring about 3 weeks before planting.

Where nematodes are considered to be the main problem use one of the following:

	L/ha	
	Row	**Broadcast**
DD	110	220
Telone II	75 - 90	150 - 180
Vorlex	28 - 40	56 - 80
Terr-o-cide 15-D	90	

NOTE: The rates of DD and Terr-o-cide 15-D and the lowest rates of Telone II, and Vorlex are considered the minimum required for nematode control.

Where black root rot, or black root rot along with nematodes, is considered to be a problem, the following treatments will provide satisfactory nematode control and may help in reducing damage from black root rot.

	L/ha
	Row
Telone C-17	75 - 100
Vorlex CP	50 - 80
Vorlex	56 - 90

NOTE: Rate of fumigant application should vary within the recommended ranges according to the likely severity of black root rot considering contributing factors such as field history of previous black root rot, cropping sequence, type of soil and tolerance of variety to be grown.

CAUTION — FUMIGANT DAMAGE: Tobacco plants may be killed or severely stunted if the fumigant has not escaped from the soil before planting. The danger of toxic amounts of fumigant remaining in the soil is greatest in low, poorly-drained areas or in heavy tobacco soil. On these soils, injecting the fumigant to a shallow depth of 10 to 15 cm should help in reducing the risk of damage. Caution should be exercised with any tobacco soil, especially when high rates of fumigant are used and/or cool, wet conditions prevail during the period between fumigating and planting.

Fields should be checked in several places, about a week before transplanting, for odor of the fumigant in the soil near the point of injection. If fumigant odor is detected, where the field has been row fumigated, the hills should be opened, about one week before planting, with a single chisel or cultivator tooth. Re-opening may be necessary if heavy rainfall and cool temperatures occur after the initial opening. Where the fumigant has been broadcast, the soil should be cultivated to the depth of the treatment zone about one week before planting.

SORE SHIN

Each year sore shin affects some plants in fields of tobacco soon after transplanting. Affected plants show brown or black discolored areas on the stem near ground level. The extent of the lesion varies, sometimes being limited to one side or, in severe cases, completely girdling the stem. Some of the affected plants die soon

after planting, while others may develop normally until later in the season when they may be broken off by wind.

Control

The disease has been noticed in the field under a wide range of moisture and temperature conditions. This may be attributed to the different strains of the fungus causing sore shin.

There is no chemical recommendation for the control of sore shin.

WEATHER FLECK

Weather fleck, a leaf disorder of flue-cured tobacco, is caused by certain oxidants in the air, mainly ozone. Oxidants damage the leaf tissue and cause the development of small spots that are irregular in shape and generally less than 4 mm in diameter. The spots are initially black, but later turn brown and eventually grayish white. The most serious losses generally occur just before or during the early part of harvest when the lower leaves are maturing.

Control

Present control measures involve cultural practices and varieties.

Certain cultural practices, such as proper spacing (page 18), proper irrigation, well-balanced fertilization, early topping and clean suckering, help to produce a leaf which is less susceptible to weather fleck. For tolerance of varieties, see pages 17 and 18.

FRENCHING

This disease occasionally appears, especially on marginal tobacco land. Severely affected plants are stunted and the leaves become thick and straplike. Sometimes only the suckers are affected.

Control

The tendency to french is definitely related to soil conditions. Improved drainage and good fertilization practices may help in avoiding the disease.

VIRUS DISEASES

(a) **Tobacco Mosaic**—The tobacco mosaic virus appears to be quite variable; consequently, symptoms on affected plants may vary also. The characteristic symptom is leaf mottling with yellow-green and dark green areas. The younger leaves are frequently blistered and malformed. The major damage is reduced yield and quality.

Control

The following preventive measures should be taken:

(1) Avoid the use of tobacco while working with seedlings either in seedbeds or during transplanting operations.
(2) Tobacco should not follow tobacco or tomatoes in rotation.
(3) Transplanting and cultivating machinery used previously for tomatoes should be washed thoroughly.
(4) Do not cultivate when plants are wet.
(5) Rogue out diseased plants if they show virus symptoms within a few weeks after transplanting.
(6) Certain weeds may become infected with mosiac, therefore proper weed control in greenhouses, fields and fencerows is important.

(b) **Tobacco Etch**—This virus disease is established in much of the burley-growing acreage in the counties of Essex and Kent. Flue-cured tobacco is occasionally infected by etch. The virus overwinters in ground cherry, of which there are two common species occurring as weeds in fencerows, waste areas, and along roadsides. In June or early July, aphids transmit the virus from ground cherry to tobacco, pepper and tomato crops.

Control

Since late-planted tobacco is severely stunted by the virus, early planting is recommended. Also, tobacco should not be planted alongside weedy fencerows or near other waste areas. The variety Harwin is moderately resistant to etch. Good aphid control should reduce the severity of the disease.

(c) **Other Viruses**—A number of other virus diseases may affect tobacco and cause severe damage. Symptoms may include severe leaf spotting, leaf mottling and death of leaf tissue. These viruses are transmitted by aphids.

Control

Tobacco fields should be checked every few days, particularly from late June until the first of August, for the presence of aphids. Apply one of the recommended insecticides (see page 7) at the first appearance of these insects.

POLE ROT

(a) **Flue-cured Tobacco**—Pole rot caused by certain bacteria or fungi frequently develops during the yellowing stage of the flue-curing process.

Control

Curing trouble of this kind is most likely to occur when yellowing is prolonged or when excessively large tobacco or wet tobacco is crowded into the kiln. This reduces air circulation, and increases humidity.

In addition, when the outside air is hot and humid, it is more difficult to reduce humidity in the kiln.

When these conditions prevail, reducing the kiln load and ventilating earlier in the cure will help prevent the development of rot.

(b) **Burley Tobacco**—Wet weather during curing often causes darkening or spoilage of burley-leaf. This injury, commonly called barn burn, is caused by fungi and bacteria growing on the cured leaves when they become too moist. Burley tobacco cures best a 65 to 70% relative humidity. Barn burn may develop rapidly if the relative humidity in the barn exceeds 85 to 90% for more than 24 hours.

Control

To avoid excessive moisture in the barn, open the ventilators during the day when the weather is dry, and close them at night to keep out dampness. When wet weather threatens, close the barn.

Special heating equipment, which maintains the proper humidity for curing and prevents barn burn, is available.

SUCKER CONTROL

The following products may be applied before or after topping. Generally an application during the early to late bud stage is the most satisfactory.

All of the products listed may be used on flue-cured tobacco. For burley tobacco, use only those products that include this tobacco type on the label.

Normally one application is sufficient. However, conditions such as an uneven crop or poor timing may reduce the effectiveness of the first application and in this case a second application may be beneficial.

NOTE: Directions for use vary somewhat from one product to another; therefore it is extremely important *to read the label carefully and follow all precautions and directions.* Conditions such as improper mixing, poor timing, boom pressures above 138 kPa (20 p.s.i.) and spraying during windy or excessively hot weather can result in crop damage. A lower rate of sucker control may be required on very tender tobacco.

LITRES OF SPRAY MIXTURE PER HECTARE

	Litres of Product		
	Before Topping	After Topping	Litres of Water
Antak	17	20	450
Chiptac	17	19	450
Contak	17	20	450
Delete	17	20	450
Emtrol	20	22	450
Emtrol Ten	17	20	450
Fair-Tac	17	17	465
Pfizol 10	17	20	450
Royaltac	17	19	450

WEED CONTROL

Ontario Ministry of Agriculture and Food Publication 75, *1982 Guide to Chemical Weed Control* contains complete information on weed control and should be referred to where more detail is required.

TOBACCO

(a) *Germinating annual weeds*
Apply diphenamid (Enide) at 6.75 kg (active)/*ha of soil sprayed.* Apply in a 25 cm band over the row in 150 to 300 L of water immediately after transplanting. Use only on flue-cured tobacco.

(b) *Germinating weeds and horsetail*
Use pebulate (Tillam) at 4.50 to 5.50 kg (active)/ha as a preplant incorporated treatment applied in 150 to 300 L of water.

Diphenamid (Enide) may persist in the soil and injure the fall cereal cover crop. To reduce this injury, it is important that diphenamid be applied in a 25 cm band and that the soil be worked at right angles to the tobacco rows after harvest.

Pebulate (Tillam) should be applied to a dry soil surface before transplanting and incorporated within 10 minutes with a double disk or springtooth cultivator. A second incorporation at right angles in tandem with a harrow should be done as soon as possible. Use 4.5 kg on light sands and 5.5 kg on loamy sands. Delay transplanting four days after application. Pebulate can also be applied at the higher rate prior to row fumigation.

RYE AND WHEAT

For more complete information on weed control in these crops refer to OMAF Publication 75, *1982 Guide to Chemical Weed Control.*

Legume plants such as vetch and clover can be especially troublesome if allowed to grow in rye or wheat fields since they add nitrogen to the soil. These and other broadleaf weeds may be controlled with 2,4-D.

Apply 425 to 550 g acid equivalent in 150 to 200 L of water/ha. **Use only the amine form.** For example, Amine 80 at 850 mL to 1.10 L/ha.

The treatment should be applied during early May, one year before tobacco. Spray before the winter grain is taller than 30 cm (top leaf extended) to ensure contact of the weeds with the chemical and reduce crop damage.

Equipment that has been used to spray 2,4-D; 2,4,5-T; MCPA or related herbicides should not be used to spray pesticides or other materials on susceptible crops such as tobacco, beans, peppers, cucumbers, tomatoes, squash, cabbage, cauliflower, pumpkins, melons and turnips. These herbicides should not be used near susceptible crops because of the danger of damage from spray drift.

Vapors from 2,4-D and related materials can injure susceptible crops.
To reduce the hazard of drift:
1. Use only the amine formulation.
2. Use coarse nozzles and low pressure.
3. Spray only on calm days.
4. Do not fill or clean the sprayer near the greenhouse or the water supply.

FERTILIZATION AND SOIL MANAGEMENT

Proper fertilization plays an essential part in maintaining maximum yields of high quality tobacco. The analyses of fertilizer and rates of application vary with the type of tobacco and the soil upon which it is grown. Effective use of fertilizers is related to soil fertility and management, soil organic matter, manure application, soil reaction, cultural methods, incidence of disease, and variety of tobacco. Commercial fertilizers supplement and balance the plant food in the soil. Suitable crop rotations and cover crops supply organic matter that reduces leaching of plant nutrients and lessens soil erosion.

The Fertilizers Act

This is an Act for the regulation and control of Agricultural Fertilizers which is administered by the Plant Products Division of Agriculture Canada.

According to regulations under the Fertilizers Act, each fertilizer to which minor elements have been intentionally added must have a label guarantee showing the amount of each minor element expressed in percent on an elemental basis.

Standards for Tobacco Fertilizers

There are special standards recommended for the forms of nitrogen and the amounts of magnesium and chlorine that should be present in tobacco fertilizers.

NITROGEN — At least one-quarter of the total nitrogen should be in the nitrate form except for side-dressing fertilizer, in which at least one-half of the nitrogen should be in the nitrate form.

CHLORINE — The level of chlorine must be controlled within narrow limits because of its effect on seedling growth and burn and moisture holding — capacity of the cured leaf. A high level of chlorine in the cured leaf lowers the burning quality and causes excess moisture uptake by the leaf. Excess chlorine in the seedbed may be toxic to young seedlings and may also contribute to damage from soluble salts.

Seedbed — It is recommended that the special tobacco seedbed fertilizer, 4-30-8, contain no more than 1.25% chlorine.

Flue-cured — The amount of chlorine is regulated as follows: (a) a fertilizer containing less than 2% nitrogen should have a maximum chlorine content of 3% and a minimum of 0; or (b) a fertilizer containing 2% or more nitrogen shall have a minimum chlorine content equal to the guaranteed nitrogen content and the maximum chlorine content shall not exceed the minimum by more than one percent. For example, a 3-9-18 analysis should contain a minimum of 3% and a maximum of 4% chlorine.

Burley — No more than 1.25% chlorine is allowed in the fertilizer.

MAGNESIUM

Seedbed — The special tobacco seedbed fertilizer, 4-30-8, should contain a minimum of 2% water soluble magnesium.

Flue-Cured — Flue-cured tobacco fertilizers, except for the seedbed fertilizer, should contain a level of water soluble magnesium that is equivalent to 40% of the guaranteed nitrogen content of the fertilizer. For example a 3-9-18 analysis should contain 1.2% water soluble magnesium.

Burley — Burley tobacco fertilizers should contain 0.6% water soluble magnesium (Mg).

Fertilizer Analyses

The following analyses are recommended by the Ontario Soil Management Research Committee.

FLUE-CURED

3-9-18 or 4-12-24	5-10-30
3-12-18	3-6-18 side-dressing fertilizer
2-10-16 or 3-15-24	9-0-27 side-dressing fertilizer
2-18-18	4-30-8 seedbed fertilizer

BURLEY

3-18-18
5-10-15 or 7-14-21
4-30-8 (seedbed fertilizer)

Seedbed Fertilization

The following recommendations are for all types of tobacco grown on muck in conventional seedbeds. Information on fertilizing seedlings produced by other methods is available on request at the Agriculture Canada Research Station, Delhi.

(a) **Before Seeding** — Apply no more than 25 kg of 4-30-8 special tobacco seedbed fertilizer/100 m^2 of seedbed area.

Fertilizer may be applied before or after steaming. Spread the fertilizer uniformly and thoroughly mix with the top 4 cm of seedbed.

CAUTION: High rates, shallow incorporation and uneven distribution of fertilizer may cause a problem with soluble salts resulting in thin stands and patchy growth.

(b) **During May** — At least two weeks before planting, apply liquid, soluble powder or granular fertilizer at a rate that will supply 0.25 kg of nitrogen (N) per 100 m^2 of seedbed area. For example, ammonium nitrate (33 - 34% N) at 0.75 kg dissolved in at least 200 L (litres) of water/100 m^2 of seedbed area. Wash the solution off the plants immediately after application, otherwise burning may occur.

If plant growth is slow and leaves are pale green this treatment may be repeated.

NOTE: (1) A shortage of nitrogen often occurs, during early May, in seedbeds that were chemically sterilized. The feeding program recommended under "During May" should begin in the first week of May in these seedbeds.

(2) Tobacco seedlings, produced on completely new muck and fertilized before seeding with the 4-30-8 analysis may develop a slight potash deficiency when they are approaching transplanting size. Although this deficiency is seldom severe enough to affect growth, it is advisable in this situation to feed during May with a complete fertilizer rather than one that supplies only nitrogen.

Soluble Salts

High levels of soluble salts often accumulate in the seedbed, causing reduced and/or delayed germination, tipping-over, stunting and root damage. Fertilizer is generally the main source of salts although in some areas the water from deep wells may be very high in salts.

(a) Preventing Salt Problems

Do not apply more than the recommended amount of fertilizer before seeding.

Leaching of the seedbed during the fall and before spreading new muck, is recommended as a means of avoiding salt problems. For effective and uniform leaching the following procedure is suggested.

Step 1 Thoroughly moisten the seedbed with a sprinkler, to the depth of soil moisture or at least 30 cm. This is easily done in June but, later in the summer or fall, several days may be required to have the seedbed uniformly moistened.

Step 2 Apply at least 10,000 L of water/100 m^2 of seedbed area. This may be done by flooding or with a sprinkler.

Step 3 After 3 or 4 days repeat step number 2.

NOTE: Thorough moistening before flooding is essential. Flooding a dry seedbed results in uneven water penetration which accomplishes salt removal in some areas but not in others.

(b) Correcting Salt Problems

During the greenhouse season salt problems usually occur in areas of the seedbed that dry most rapidly (loose areas or areas receiving less water).

This problem can be corrected by leaching. In fact, if the problem is detected early enough, corrective measures can produce a normal stand of plants. Samples of muck, from the seedbed, may be tested at the Research Station to determine the level of soluble salts.

To obtain effective leaching, first moisten the seedbed and then apply at least 2,500 L of water/100 m^2 of seedbed area. If, after testing a sample, the salts are still high, repeat the leaching procedure.

Field Fertilization

Fertilizer requirements for tobacco should be determined by using a soil test along with information on soil type, past management and yield and quality of tobacco usually produced on the field.

Nitrogen, phosphate and potash are the main nutrients to be considered in a fertilizer program. To provide dependable recommendations each field should be tested every second year.

Phosphate and Potash—Phosphate and potash requirements for flue-cured and burley tobaccos are presented in the following table. This table should not be used with soil test readings from other soil testing laboratories unless the methods used are identical to those used in the OMAF laboratory. After deciding on the amount of nitrogen you wish to apply choose an analysis of fertilizer that most closely fits the phosphate and potash requirements as indicated by your soil test.

NOTE: Where there is a requirement of more than 180 kg of phosphate and 220 kg of potash it is considered best to apply the additional amounts as a separate application rather than in bands at planting time.

PHOSPHATE AND POTASH REQUIREMENTS FOR TOBACCO BASED ON OMAF SOIL TESTS

Phosphorus Soil Test (PPM)	Rating	Phosphate (P_2O_5) Required—kg/ha	Potassium Soil Test (PPM)	Rating	Potash (K_2O) Required—kg/ha
0-3			0-15		
4-5			15-30		
6-7	Low		31-45	Low	
8-9			46-60		
10-12			61-80		
13-15			81-100		
16-20			101-120		
21-25			121-150		
26-30	Medium		151-180	Medium	
31-40			181-210		
41-50					
			211-250	High	110
51-60		80			
61-80	High	50	250+	Very High	100
80+	Very High	20			

Flue-Cured Tobacco Fertilization

Nitrogen—Under Ontario conditions there is no reliable test for nitrogen. In addition the amount of nitrogen available from organic matter will vary from season to season depending largely on rainfall and temperature. For these reasons it is extremely difficult to determine the optimum amount to apply.

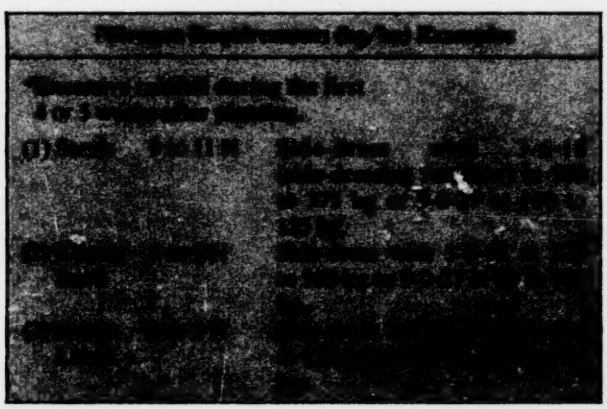
Usually previous tobacco crops provide the most reliable basis for determining the nitrogen requirement. A record of each field should be kept over the years to have an accurate picture of maturity, size, quality and yield for more than one tobacco crop year. The amount of nitrogen applied to previous tobacco crops may be used as a base from which to determine nitrogen requirements within a certain range.

GENERAL NITROGEN RECOMMENDATIONS

	kg/ha Nitrogen	Examples kg/ha
Sand	30-36	1000 to 1200 kg of a 3% nitrogen fertilizer such as 3-9-18 or 750 to 900 kg of a 4% nitrogen fertilizer such as 4-12-24 or 600 to 720 kg of a 5% nitrogen fertilizer such as 5-10-30
Loamy Sand	24-27	800 to 900 kg of a 3% nitrogen fertilizer such as 3-12-18 or 3-9-18
Sandy Loam	16-20	800 to 1000 kg of a 2% nitrogen fertilizer such as 2-10-16 or 2-18-18

Magnesium—Magnesium is usually supplied in sufficient quantities in the complete fertilizer to prevent magnesium deficiency commonly called "sand drown". If the need for additional magnesium is indicated by soil test, the source and amount to be applied will be specified in your fertilizer recommendations.

SIDE DRESSING



**25 mm (millimetres) or more of rainfall during a 24-hour period, when the soil is moist prior to the rain, is generally considered excessive. Other factors to consider in deciding whether to side-dress are: soil texture, soil fertility and drainage.*

A range of 16 to 36 kg/ha of nitrogen will cover practically all situations from sandy loam to sandy soils. Using the rate applied to previous crops as a base you can make adjustments within the indicated range depending on your judgement of the nitrogen-supplying power of the soil. It is generally considered that an adjustment of at least 4 kg/ha of nitrogen would be required to make any significant change in the crop. Also adjustments in the direct fertilizer application of nitrogen may help but cannot be expected to completely correct a problem of too much or too little nitrogen in the soil. The use of nitrogen on the previous rye or wheat crop and the application of manure are just as important as the amount of nitrogen directly applied to the crop.

Burley Tobacco Fertilization

Sandy loam and gravelly loam soils produce the best quality burley. Clay loam soils tend to produce tobacco too high in chlorine and too low in potassium content, two factors that contribute to poor burning quality. The production of burley with good burning quality is of utmost importance if the domestic and export markets are to be maintained and expanded.

Nitrogen—Under Ontario conditions there is no reliable test for nitrogen. The decision on the amount of nitrogen required should be based on past fertilization, cropping history and the performance of previous burley crops.

The following table serves as a guide for inexperienced growers or growers who may want to change their fertilization management in order to adapt to the heavier and darker quality burley that is now required by the industry.

	Total Actual Nitrogen applied (kg/ha)
1. Sands to Loamy Sands	250
2. Sandy or Gravelly Loams	200
3. Sandy Loams to Loams	170

NOTE: Fertilization formulations containing muriate of potash (potassium chloride) should not be used on burley tobacco because of the high chlorine level which lowers the burning quality of the leaf.

Manure

Manure can be used as a source of plant food and organic matter. The content of N, P_2O_5 and K_2O in manure is extremely variable. Chemical analysis will indicate more accurately, then the following table, the amounts of nutrients available for crop production from the particular manure you intend to use, provided a representative sample can be obtained. A manure analysis service is offered through the Department of Land Resource Science, University of Guelph. Cost of this service is shown in the table on page 24. Manure

AVERAGE PLANT FOOD AVAILABLE FROM MANURE IN FIRST CROP YEAR

testing kits are available at County Agricultural Offices. Figures in the following table are an average and should be considered only as a rough guide.

FLUE-CURED TOBACCO

Manure is not required on many farms where nitrogen is used during the spring and summer on the rye or wheat crop. However, sandy tobacco soils, particularly sandy knolls, usually benefit from an application of 12 to 18 tonnes/ha of cattle or swine manure. As the table indicates, poultry manure is high in nitrogen and is generally not recommended.

The use of manure on soils high in fertility is likely to delay maturity and to lower quality.

BURLEY TOBACCO

If manure is to be used, it should be applied at least a year before the burley crop. This allows for adequate decomposition of the organic matter and the disappearance of chlorine. Manure applied too close to tobacco delays maturity, increases the chlorine content, and lowers burning quality of the leaf.

Rotations

FLUE-CURED TOBACCO

In a two-year rotation with tobacco, rye has generally proven to be better than wheat in maintaining or increasing the amount of organic matter in the soil. Wheat is more subject to winter kill and factors such as fall seeding date, nutrient shortage and pH are much more critical with wheat as compared to rye. For example, wheat can be seriously affected in certain fields by a shortage of manganese while in the same fields tobacco and rye grow normally. Wheat may be substituted for rye where fertility is high, especially on soils with a sandy loam to loam texture. Wheat is unlikely to produce sufficient crop residue on medium to course-textured tobacco soils.

FERTILIZATION OF RYE

	Nitrogen (kg/ha)	Examples (kg/ha)
(a) Early spring when growth starts		
(1) Sand	45	Ammonium nitrate (33-34% N) at 135 kg or Urea (45-46% N) at 100 kg.
(2) Loamy Sand	35	Ammonium nitrate at 105 kg or Urea at 80 kg.
(3) Sandy Loam	25	Ammonium nitrate at 75 kg or Urea at 55 kg.

NOTE: (1) Less than 25 kg of N should be applied in the summer to sandy loam soils where slow maturity has been experienced in the tobacco crop.

(2) Maturity of tobacco may be delayed if nitrogen is applied after mid-August or at a high rate.

FERTILIZATION OF WHEAT

Wheat should generally be fertilized in the spring with double the nitrogen rates recommended for rye in the previous table. Rates should be reduced by one-half in fields where tobacco is oversized and matures late or in medium to heavy soils where the field has been out of tobacco for more than one year.

For crop residues apply the same rate of nitrogen as indicated for rye and according to the precautions in notes (1) and (2).

BURLEY TOBACCO

Burley should not follow crops where high rates of muriate of potash have been used because of the danger of increasing the chlorine level and lowering the burning quality of the leaf.

Burley is usually grown in rotation with other crops. Crop rotation is important to minimize virus diseases, to reduce the buildup of black root rot disease, and to maintain good soil structure and composition.

The crop grown before burley is important in the rotation. Winter wheat and a winter cover crop of fall rye are two of the best. Tomato and tobacco are very closely associated and have similar diseases. They should not follow one another closely in a rotation. There is a risk with a legume crop such as alfalfa or clover, before burley, unless plowed in the fall. Spring plowing of leguminous crops usually results in later maturity and a darker or lower quality leaf.

Continuous cropping of burley tobacco on the same soil can improve leaf quality but black root rot disease is more common under conditions of continuous culture, particularly under cool, wet conditions in the spring. Stands may become spotty or drastically reduced. Soil structure can also be impaired under a burley monoculture unless a winter cover crop of fall rye is incorporated into the sequence.

Soil Testing

Fall is the best time to take soil samples. Soil sample boxes and questionnaire forms may be obtained from your nearest Research Station, College of Agricultural Technology, Agricultural office, or from the Department of Land Resource Science, University of Guelph. Proper sampling procedure is outlined on the questionnaire.

Tissue Testing

A service for the chemical analysis of plants and other organic materials such as sludge and manure is available at the Department of Land Resource Science, University of Guelph. This service is available on a charge per sample basis. For more information inquire at your local Agricultural office or Research Station.

Micronutrients

Additions of the micronutrients boron, copper, iron, manganese, molybdenum and zinc are generally not required for tobacco in Ontario. Surveys of tobacco soil and leaf tissue show that levels are usually adequate and, in some cases, excessive. For example, very high levels of iron, manganese and zinc are occasionally found in the cured leaf and these are associated with a certain type of "grey" tobacco.

Before applying any micronutrient it is important to establish the need since the range between beneficial and harmful amounts is very narrow. A tissue test for boron, copper, manganese and zinc is available on a charge per sample basis through the Soil Testing and Plant Analysis Laboratory, Department of Land Resource Science, University of Guelph. The same laboratory offers a soil test for manganese and zinc, also on a charge per sample basis (see page 24).

Liming

The need for limestone is determined by testing the soil to find the reaction (pH). On tobacco soils the most reliable indication of pH is obtained from late fall or early spring sampling. The soil pH for tobacco should be above 5.5. Wheat, which is often grown in rotation with tobacco, is favored by a pH of 6.0 or slightly above.

Limestone is recommended when the soil pH is below 5.6. Dolomitic limestone should be used at rates of 2 tonnes/ha when the pH is within the range of 5.1—5.5 and 5 tonnes/ha when the pH is below 5.1.

Two tonnes/ha of limestone will raise the pH by one-half to one unit, ie: 5.5 to 6.0 or 6.5, on a light-textured tobacco soil and somewhat less where the soil is heavier and/or higher in organic matter. Excessive use of limestone to increase the pH beyond 6.5 will decrease the availability of certain essential minor elements and create favorable conditions for the development of black root rot.

NOTE: Plowing limestone directly into the soil, without prior working in, is likely to reduce the effectiveness of limestone in raising pH.

Fertilizer Placement

The total quantity of complete fertilizer should be applied at transplanting time in bands 10 cm on each side of the row, and level with or slightly below the root crown (8 to 10 cm deep).

CAUTION: Closer placement of fertilizer could result in root injury, and wider placement could delay early growth.

Broadcasting a complete tobacco fertilizer is a wasteful practice, and may be detrimental to yield and quality under high rainfall or excessive irrigation.

Starter or Transplanting Fertilizers

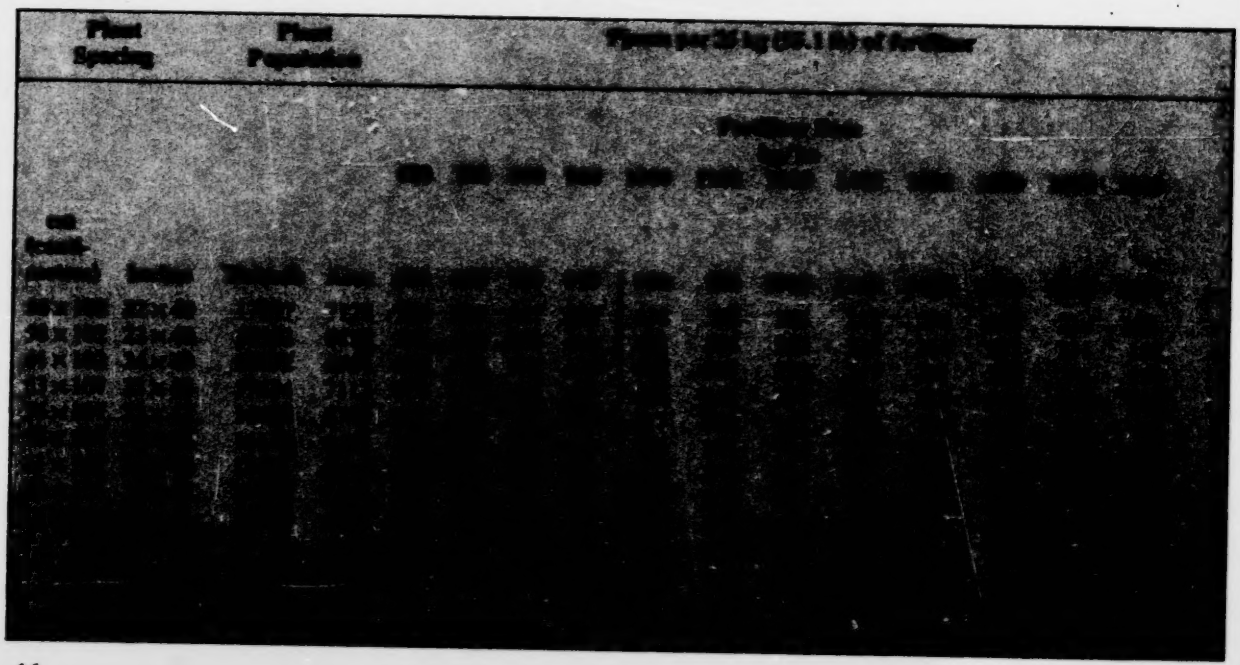
Starter fertilizers are not recommended. These fertilizers in combination with certain insecticides in the planting water may injure newly transplanted plants, causing either death or stunting (see page 6 under **Seed Maggots**).

Foliage Feeding

Although the tobacco plant can absorb certain nutrients through the leaves in small amounts, spraying fertilizer on the leaves is an impractical method of correcting nitrogen, phosphorus, or potassium deficiency. If additional amounts of these nutrients are required after transplanting, a side-dress application is recommended.

Calibration of Tobacco Fertilizer Applicators

A fertilizer applicator should be calibrated periodically to ensure desired rates of fertilizer application. The amount of fertilizer per plant depends on the plant spacing and rate of application as shown in the following table. For example, when applying 1000 kg/ha of fertilizer and using a plant spacing of 61 x 107 cm (24 x 42 inches), 25 kg will fertilize 383 plants.



When calibrating an applicator, first place and level approximately 15 kg of fertilizer in the hopper, mark this level, and then put in 25 kg of fertilizer. Plant the desired number of plants, as shown on the table, and check the level in the hopper. If the fertilizer is above the mark, too little is being applied, and if below the mark, too much is being applied. Do not place the fertilizer in the hopper until immediately before transplanting, to avoid packing, as this will result in poor calibration. This method will give a fairly accurate calibration of the rate of application, but it is also advisable to check the fertilizer on an acre and field basis.

VARIETIES

FLUE-CURED TOBACCO

Varieties of flue-cured tobacco recommended for use in Ontario are: Delgold, Delhi 76, Newdel, Nordel, and Virginia 115. In recent years, breeding for increased alkaloid content has been emphasized. The newer recommended varieties Delgold, Newdel and Nordel reflect improvements in this area.

The following variety descriptions are from comparisons made at the Research Station, Delhi, where all have received the same treatment.

DELGOLD was developed at the Research Station, Delhi, from crosses involving *Nicotiana Rustica,* Hicks Broadleaf, and Virginia 115. The plant is light green in color and is fast growing in the greenhouse and in the field. It has intermediate to high tolerance to black root rot and to weather fleck. Delgold is tall and is cylindrical in shape. The leaf has good width, is longer than Virginia 115 but is narrower in the butt section. Ground sucker growth is quite low, Toughness of the leaf at harvest time compares favorably with Virginia 115. The variety is high yielding and cures easily. In the cured leaf, shades of light orange will predominate throughout the mid-stalk leaves while the upper leaves will range from a light orange to orange color.

DELHI 76 was developed at the Research Station, Delhi from treatment of Delhi 34 seed with Gamma rays to induce mutations. The plant is medium green in color and fast growing in the greenhouse and in the field. It is tall with leaves equally spaced up the stalk. Ground sucker growth may be a problem on some farms. Delhi 76 has a high tolerance to black root rot and to weather fleck. The yield is high and the leaf cures satisfactorily to an orange color particularly in the upper leaves. The leaf cures easily and has good texture and graininess.

NEWDEL was developed at the Research Station, Delhi from crosses involving *Nicotiana Rustica,* Delhi 34 and Virginia 115. The plant is light green in color, medium tall and tapers slightly toward the top. It is fast growing in the greenhouse and in the field. The leaf has good width and length. Newdel has intermediate tolerance to black root rot and is intermediate to high in tolerance to weather fleck. The variety is intermediate to high in yield and cures easily to a uniform color. In the cured leaf, shades of rich light orange color will predominate.

NORDEL was developed at the Research Station, Delhi from crosses involving *Nicotiana Rustica,* Delhi 34 and Virginia 115. Nordel is light green in color and is fast growing in the greenhouse and in the field. It has intermediate to high tolerance to black root rot and intermediate tolerance to weather fleck. The plant style is somewhat similar to Virginia 115 but the plant is a little taller and the top elongates more like Delhi 76. Ground sucker growth has not been a problem but may be more than that of Virginia 115. The yield is intermediate and the cured leaf tends to be a light orange to orange color.

VIRGINIA 115 was developed in the U.S.A. from a cross between Hicks Broadleaf and Coker 139. Virginia 115 is a short-stalked plant with closely spaced leaves. Early seedling growth may be slow, with heart leaves yellowish and slightly deformed. However, the variety will outgrow these characteristics and produce vigorous seedlings by transplanting time. Virginia 115 is intermediate in tolerance to black root rot and intermediate to high in tolerance to weather fleck. The tip leaves require adequate moisture to fill out properly and the lower leaves may be affected by leaf drop. The sand leaves are often primed before topping. The tip leaves are slightly narrow and distinctly crinkled. Virginia 115 is intermediate to high in yield. The cured leaf tends to have good texture and graininess, but is less uniform in color than Delhi 76. Muddy-faced leaves may appear in the mid-stalk and upper-stalk primings.

BURLEY TOBACCO

BURLEY 1—High yielding with a high percentage of leaf in the cutter grades; moderately low in nicotine. Resistant to black and brown root rots, but susceptible to common mosaic and tobacco etch. Well-adapted to a wide range of soil conditions. Plants tall, semi-erect and attractive, with 28 to 30 leaves when topped; leaves medium in size.

HARWIN—Higher yielding than Burley 1 but two or three days longer in ripening; slightly lower in nicotine than other varieties. Resistant to black and brown root rots and moderately resistant to tobacco etch, but susceptible to common mosaic. Plants tall and attractive, resembling Burley 1 but slightly darker green; lower leaves larger than those of Burley 1, and lighter in color when cured.

KENTUCKY 21 × 10—The hybrid is a high yielding variety with superior grade quality. The quality of the lower leaves is maintained over a somewhat longer time so that it can be harvested later than Burley 1 or Harwin. Topping height, leaf number and days to flower are similar to Burley 1 but tolerance to black root rot is slightly lower. This variety is tolerant to both tobacco mosaic virus and wildfire diseases.

Variety	Yield kg/ha	Grade Index $/kg	Number of Leaves	Days to Topping	Height cm	Cured Leaf kg/ha
Delhi 76	3039	3.01	18.8	67.2	100.7	47.6
Delgold	3172	3.00	18.1	68.4	97.5	9.6
Newdel	2969	2.96	18.1	68.1	96.5	52.6
Nordel	2784	2.96	17.5	68.3	96.0	21.6
Virginia 115	2933	2.95	17.5	61.0	88.8	14.3

Variety	Black[1] Rot Rating	Weather[2] fleck	Company[3] Rating	Total Alkaloids %	Reducing Sugars %
Delhi 76	127	1.1	77.8	2.94	18.89
Delgold	111	1.5	72.5	3.17	17.35
Newdel	98	1.7	66.9	3.23	16.31
Nordel	112	2.3	67.6	3.45	15.35
Virginia 115	100	1.6	71.6	2.65	17.86

[1] *Higher number more tolerance*
[2] *Lower number more tolerance*
[3] *1979 and 1980 Data, Average of 4 companies, higher number preferred*

SUMMARY OF GRADES EXPRESSED AS PERCENT (3-Year Average 1979-1981)

Variety	Sands %	CL %	CF %	BL %	BF %	ND %	CR %
Delhi 76	6.9	24.2	4.8	9.4	45.1	0.6	0.6
Delgold	7.3	19.6	7.2	14.6	44.4	0.9	1.9
Newdel	8.0	19.9	5.9	17.0	40.8	1.0	2.9
Nordel	6.9	21.3	5.6	10.7	47.0	1.0	1.4
Virginia 115	8.0	25.2	3.4	8.5	44.2	0.7	1.8

CULTURAL PRACTICES

Plant Population and Spacing

FLUE-CURED TOBACCO

The most desirable plant population will vary somewhat from farm to farm depending mainly on soil fertility. A suitable population for most farms is within a range of 15321 to 17634 plants/ha (6200 to 7100 plants per acre). Slightly higher yields may be obtained with higher populations but this advantage may be offset by the added costs of handling more leaves. Also, as plant popultion is increased, there is a tendency to produce a thinner leaf which may be more susceptible to weather fleck.

As row width is increased up to 122 cm (48 inches) yield tends to decrease.

Recommended plant spacings for flue-cured tobacco are indicated in the shaded area of the following table:

	Plant Spacing Within the Row							
Row Width	*41 **16	46 18	51 20	53 21	56 22	58 23	61 24	66 26
*102	***23,912	21,313	19,223	18,498	17,307	16,988	16,072	14,854
**40	**** 9,801	8,712	7,840	7,468	7,128	6,868	6,534	6,032
107	22,795	20,317	18,325	17,624	16,988	16,413	15,501	14,160
42	9,334	8,297	7,467	7,112	6,760	6,498	6,215	5,744
112	21,777	19,410	17,502	16,836	16,248	15,394	14,637	13,528
44	8,910	7,920	7,128	6,760	6,480	6,154	5,940	5,483
117	20,846	18,580	16,752	16,112	15,263	14,736	14,011	12,950
46	8,523	7,576	6,868	6,498	6,198	5,929	5,682	5,244
122	19,992	17,819	16,072	15,501	14,637	14,132	13,437	12,419
48	8,168	7,280	6,534	6,215	5,940	5,682	5,445	5,026

* *Centimetres* ** *Inches*
*** *Plants per hectare* **** *Plants per acre*

BURLEY TOBACCO

Burley tobacco is usually transplanted 41 cm apart in the row and 102 cm apart between rows (about 16 × 40 inches) giving a plant population of 23,912 plants per ha (about 9,800 plants per acre). This plant spacing promotes quality and yield of tobacco without seriously hampering topping, suckering, and harvesting operations.

Irrigation

For more information on irrigation refer to the following Ontario Ministry of Agriculture and Food Factsheets: *Tobacco Irrigation With Gun Sprinklers* Agdex No. 181/565, March, 1980 and *Tobacco Irrigation With Travelling Gun Sprinklers* Agdex No. 181/565, November, 1981.

A permit is required for the taking of more than 10,000 gallons of water in a day from any ground or surface source of water supply, or a combination thereof for the purpose of irrigating. For further information contact your nearest office of Ontario Ministry of the Environment.

Specific instructions cannot be given for irrigating tobacco. There is too much variation in rainfall pattern, soil type, temperature and other factors that affect moisture availability and rates at which plants use water. However, there are general guides that are helpful in making the important decisions, such as when to irrigate and how much water to apply.

Tobacco may be irrigated any time during the day or night. Irrigation is more efficient during the night because less water is lost through evaporation and usually there is very little wind.

WHEN TO IRRIGATE

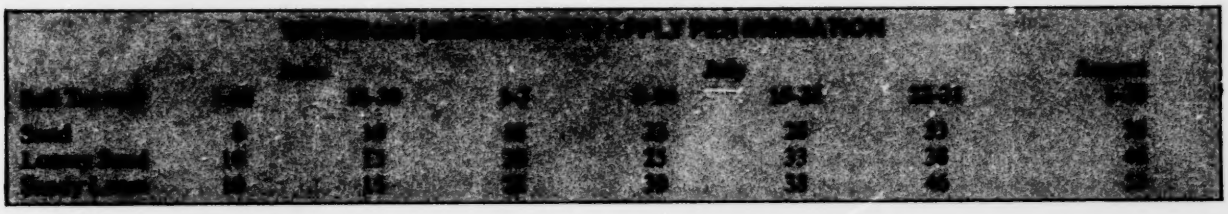
Stage and development of the crop are two important considerations in determining when to irrigate. A slight shortage of moisture between the time the tobacco crop is established and early July is not considered harmful. From early July until topping time (stage of rapid growth), moisture requirements are more critical. Irrigation during harvest is occasionally necessary to promote development of the tip leaves and hasten the maturity of the crop.

The most commonly used method of determining when to irrigate is careful observation of the crop and soil, combined with past experience and the amount of rainfall. Although this method has been reasonably successful, it may indicate the need for irrigation too late to obtain maximum benefits.

A more accurate method involves the keeping of a day-by-day record of the soil moisture supply. Daily moisture use is calculated according to stage of growth and temperatures. When this is combined with an accurate record of rainfall the soil moisture supply can be established. Information on this method may be obtained at the Research Station, Delhi.

HOW MUCH WATER TO APPLY

The objective in irrigation is to saturate the soil to the depth of the main concentration of roots. Therefore the amount of water to apply, when irrigation is necessary, will vary with soil type and time of season.



Topping

FLUE-CURED TOBACCO

Time and height of topping have a major influence on tobacco quality and yield.

Experimental results indicate that the optimum time for topping is just after the top has stretched and before any flowers have opened. Topping all plants, or as many as possible, at the same time, encourages uniform maturity.

Although high topping generally produces more yield than lower topping, maturity of the upper leaves is enhanced by topping so that a good-sized tip leaf is produced [about 50 cm in length when full grown]. The proper height of topping for maximum quality will vary from one farm or field to another and depends mainly on variety, rainfall distribution, fertility, and time of season. Under average conditions present varieties are capable of producing 17 to 18 leaves.

BURLEY TOBACCO

Burley is topped when 75% of the plants are in full bloom. Topping all plants at the same time encourages uniform maturity at harvest. A medium topping height is preferred by some buyers.

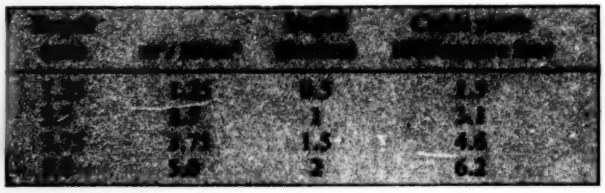
Many growers use a spray program recommended for burley sucker control. This spray is usually applied immediately before or after topping (see page 20).

SEEDLING PRODUCTION

For more complete information on the production of tobacco seedlings refer to Ontario Ministry of Agriculture and Food Publication 7 *Producing Tobacco Transplants in Ontario*.

MUCK REQUIREMENT — A uniform layer of muck about 5 cm thick is necessary to provide good conditions for seedling growth. Most growers, rather than remove the old muck each year, simply add a small quantity of new muck.

The following table is intended as a guide to the amount required when purchasing new muck.



SEEDING RATES — The amount of seed required to achieve a good stand of plants (120 per 930 cm²) will vary according to management, type of greenhouse and whether vermiculite is used as a covering after seeding.

Generally the seeding rate without vermiculite should range between 28 g to 165 m² and 28 g to 220 m². Past experience in the particular greenhouse under your own management should be considered in determining the seeding rate. Many growers find that rates in the centre of the range are most satisfactory.

Reduce the seeding rate by 15 to 20% if you plan to use vermiculite as a covering after seeding.

USING VERMICULITE — This material applied as a covering after seeding helps to reduce loss of plants from excess heat and/or dryness and tipping-over.

Several grades of vermiculite are available but you should use only the grade specified for tobacco seedbeds. Sufficient vermiculite should be used to cover but not completely hide the muck surface. One 7 kg bag should cover about 20 m² of seedbed.

Uniform application is essential since plants may not emerge from areas where there is a deep layer of vermiculite (over 1 cm).

As suggested under **Seeding Rates**, 15 to 20% less seed should be used where you plan to use vermiculite immediately after seeding. Vermiculite may be applied later if plant losses to "tipping-over" are excessive.

HARDENING-OFF — Although plants may be hardened through various combinations of moisture stress and greenhouse temperatures, one of the oldest and best methods involves forking and drying the seedbed. Refer to page 15 of OMAF Publication 7 for details on the procedure for "forking".

Normally forking would be done about 2 weeks before planting. Where a mechanical plant puller is to be used seedbeds should be forked about 3 weeks before the start of planting.

GENERAL INFORMATION

SPRAYER CALIBRATION

Here is a simple method of determining the number of litres of spray material being applied to a hectare.

1. Set out two stakes 100 m apart.
2. Pick a level spot and fill the sprayer tank with water. Operate the sprayer to be sure that the supply line up to the shutoff valve is full before finally filling the tank. RECORD THE WATER LEVEL ON A MEASURING STICK.
3. Spray between stakes in one direction only at a **DEFINITE SPEED AND PUMP PRESSURE.** Turn the boom on as the first stake is passed, and turn the boom off as the second stake is passed. The by-pass pressure relief value must be set to give the desired pressure when the shutoff valve is open. **MARK THE THROTTLE SETTING.**
4. Return the sprayer to the same location as before the calibration run. Carefully measure the amount of water required to refill the tank to the same mark on the measuring stick.
5. Calculate the application rate in L/ha using this formula:

$$\frac{\text{litres of water added} \times 100}{\text{boom length (in metres)}} = \text{L/ha}$$

SAMPLE CALCULATIONS Overall Spraying: If the sprayer has a 5.35 m boom and 12 L of water are required to refill the tank, the application rate is:

$$\frac{12 \times 100}{5.35} = 224 \text{ L/ha}$$

Band Spraying: If the sprayer has 4 nozzles and each nozzle covers a 25 cm band, the total width of the spray patterns (boom length) is:

$$4 \times 25 = 100 \text{ cm or } 1 \text{ m}$$

If 2.5 L of water is required to refill the tank, the application rate is:

$$\frac{2.5 \times 100}{1} = 250 \text{ L/ha}$$

When band spraying, the acreage actually sprayed is NOT the same as the crop acreage. The herbicide rates given in this publication are based on the acreage actually sprayed.

WATER TANK CAPACITY

$$\text{Capacity in litres} = \frac{\text{Volume in cc (cubic centimetres)}}{1{,}000}$$

To find the volume of:

(1) Round tank with flat bottom and top 3.14 × (radius in cm)² × height in cm
(2) Rectangular tank
Length in cm × width in cm × height in cm

METRIC EQUIVALENTS

Length

inch	= 2.54 cm	millimetre	= 0.039 in.
foot	= 0.3048 m	centimetre	= 0.394 in.
yard	= 0.914 m	decimetre	= 3.937 in.
mile	= 1.609 km	metre	= 3.28 ft.
		kilometre	= 0.621 mile

Area

square inch	= 6.452 cm^2
square foot	= 0.093 m^2
square yard	= 0.836 m^2
square mile	= 2.59 km^2
acre	= 0.405 ha

cm^2	= 0.155 sq in.
m^2	= 1.196 sq yd
km^2	= 0.386 sq mile
ha	= 2.471 acres

Volume (dry)

cubic inch	= 16.387 cm^3
cubic foot	= 0.028 m^3
cubic yard	= 0.765 m^3
bushel	= 36.368 litres

cm^3	= 0.061 cu in.
m^3	= 35.31 cu ft
hectolitre	= 2.8 bu
m^3	= 1.308 cu yd

Volume (liquid)

Fluid ounce (Imp)	= 28.412 mL
pint	= 0.568 litre
gallon	= 4.546 litres

litre	= 35.2 fl oz
hectolitre	= 21.997 gal

Weight

ounce	= 28.349 g
pound	= 453.592 g
hundredweight (Imp)	= 45.359 kg
ton	= 0.907 tonne

gram	= 0.035 oz avdp
kilogram	= 2.205 lb avdp
tonne	= 1.102 short ton

Proportion

1 gal/acre	= 11.232 litres/ha
1 lb/acre	= 1.120 kg/ha
1 lb/sq in.	= 0.0702 kg/cm^2
1 bu/acre	= 0.898 hL/ha

1 litre/ha	= 14.24 fl oz/acre
1 kg/ha	= 14.5 oz avdp/acre
1 kg/cm^2	= 14.227 lb/sq in.
1 hL/ha	= 1.112 bu/acre

CONVERSION FACTORS, IMPERIAL TO METRIC

Imperial Units	Approximate Conversion Factor	Results in:
Linear		
inch	× 2.5	centimetres (cm)
foot	× .3	metre (m)
mile	× 1.6	kilometre (km)
Area		
square inch	× 6.5	square centimetres (cm^2)
square foot	× .09	square metre (m^2)
acre	× .4	hectare (ha)
Volume		
cubic foot	× .03	cubic metre (m^3)
fluid ounce	× 28.	millilitre (mL)
gallon	× 4.5	litres (L)
Weight		
ounce	× 28	grams (g)
pound	× .45	kilogram (kg)
ton	× .9	tonne (t)
Pressure		
pounds per square inch	× 6.9	kilopascals (KPa)
Proportion		
fluid ounce per acre	× 70	millilitre per hectare (mL/ha)
gallon per acre	× 11.2	litres per hectare (L/ha)
pounds per acre	× 1.12	kilogram per hectare (kg/ha)
ton per acre	× 2.24	tonne per hectare (t/ha)
plants per acre	× 2.47	plants per hectare (plants/ha)

WEIGHTS AND MEASURES

1 imperial gallon	= 4 quarts = 8 pints = 160 fluid ounces = 10 pounds of water approximately 1.2 U.S. gallons
1 U.S. gallon	= .8345 or approximately 5/6 imperial gallon
1 imperial quart	= 2 pints = 40 fluid ounces
1 ton	= 2,000 pounds
1 pound	= 16 ounces
1 ppm	= one part per million by weight = 1 pound in 100,000 gallons of water
100 ppm	= 1 pound in 1,000 gallons of water = 1.6 ounces in 100 gallons of water
1 mile	= 5,280 feet = 1,760 yards = 320 rods
1 rod	= 16.5 feet = 5.5 yards
1 yard	= 3 feet = 36 inches
1 foot	= 12 inches
1 acre	= 43,560 square feet = 4,840 square yards = 160 square rods
1 square yard	= 9 square feet
1 square foot	= 144 square inches
1 mile an hour	= 88 feet a minute

METRIC TO IMPERIAL

Metric Units	Approximate conversion factor	Results in:
Linear		
millimetre (mm)	× 0.04	inch
centimetre (cm)	× 0.03	foot
metre (m)	× 1.1	yard
kilometre (km)	× 0.62	mile
Area		
square centimetre (cm^2)	× 0.15	square inch
square metre (m^2)	× 11.1	square foot
hectare (ha)	× 2.5	acre
Volume		
cubic centimetre (cm^3)	× 0.06	cubic inch
cubic decimetre (dm^3)	× 0.03	cubic foot
cubic metre (m^3)	× 1.2	cubic yard
millilitre (mL)	× 0.03	fluid ounce
litre (L)	× 1.7	pint
litre (L)	× 0.91	quart
litre (L)	× 0.22	gallon
hectolitre (hL)	× 2.8	bushel
Weight		
gram (g)	× 0.03	ounce
kilogram (kg)	× 2.2	pound
tonne (t)	× 1.1	short ton (2000 lb)
Pressure		
kilopscal (kPa)	× 0.14	pounds per square inch
Power		
watt (W)	× 0.0013	horsepower
kilowatt (kW)	× 1.3	horsepower
Speed		
metres per second (m/s)	× 3.3	feet per second
kilometres per hour (km/h)	× 0.62	miles per hour
Agriculture		
litres per hectare (L/ha)	× 0.09	gallons per acre
litres per hectare (L/ha)	× 0.36	quarts per acre
litres per hectare (L/ha)	× 0.71	pints per acre
millilitres per hectare (mL/ha)	× 0.014	fluid ounces per acre
tonnesd per hectare (t/ha)	× 0.45	tons per acre
kilograms per hectare (kg/ha)	× 0.90	pounds per acre
grams per hectare (g/ha)	× 0.014	ounces per acre
plants per hectare (plants/ha)	× 0.41	plants per acre

TEMPERATURE CONVERSION

°C	°F	°C	°F
—18	0	10	50
—15	5	15	59
—10	14	20	68
—5	23	25	77
0	32	30	86
5	41	35	95
		40	104

REFERENCES FOR FURTHER INFORMATION

Publications available from the Information Branch, Ontario Ministry of Agriculture and Food, Legislative Buildings, Toronto M7A 1A5:

7 Producing Tobacco Transplants in Ontario
75 1982 Guide to Chemical Weed Control

Factsheets— *Soil Acidity and Liming*
Winter Wheat in Ontario
Air Pollution and Horticultural Crops
Blue Mold of Tobacco
Tobacco Irrigation with Gun Sprinklers

Publications available from Information Division, Agriculture Canada, Ottawa:
1641 *Tobacco Diseases*
1415 *Control of Nematodes in Flue-cured Tobacco in Ontario*
1312 *Curing Flue-cured Tobacco*
1217 *Culture of Cigarette Burley Tobacco*
1228 *Varieties of Burley Tobacco for Southwestern Ontario*

Publications available from the Ontario Ministry of the Environment, Department of Environmental Biology, University of Guelph, Guelph, Ontario.

Personal Protective Equipment for Pesticide Users
Chemical Safety Handbook
Pesticides Act and Regulations
Chemical Storage Signs
Aluminum Phosphide for Groundhog Control

CROP INSURANCE

The Government of Ontario, in cooperation with the Federal Government and through the Crop Insurance Commission of Ontario, offers crop insurance protection for tobacco and several other crops. As a result of a Federal Government subsidy of 50% of the premium and with administration costs paid entirely by the Provincial Government, this valuable protection is available to Ontario farmers at less than half the total cost. The premium is also tax-deductible as an operating expense.

Crop insurance offers protection against losses from a broad range of production hazards including hail, frost, flood, drought, wind, excess moisture and/or rainfall, insect damage and disease.

For further information on Crop Insurance for tobacco contact The Crop Insurance Commission of Ontario, Ministry of Agriculture and Food, Legislative Buildings, Toronto, Ontario, M7A 1B7 or the area office at the Research Station, Delhi, N4B 2W9.

1982 TOBACCO PRODUCTION RECOMMENDATIAONS

ACKNOWLEDGMENTS

The recommendations contained in this publication have been prepared in consultation with:
— Ontario Crop Protection Committee
— Ontario Soil Management Research Committee
— Ontario Weed Committee
— Ontario Tobacco Committee

and personnel of

— Soils and Crops Branch, Ontario Ministry of Agriculture and Food
— Agriculture Canada
— Ridgetown College of Agricultural Technology
— Ontario Agricultural College, University of Guelph
— Ontario Ministry of the Environment
— Ontario Ministry of Labour
— Health and Welfare Canada

Analyses Available through the Soil Testing and Plant Analysis Laboratory, Department of Land Resource Science, University of Guelph

Material	Analyses	Availability	Cost/sample
1. Farm soils	plant available phosphorus, potassium and magnesium + pH (calcium and salt concentration* if required)	all times	no charge — cost borne by Ontario Ministry of Agriculture and Food
2. Home garden and lawn soils	as above	all times	$1.00
3. Soil	organic matter	enquire at lab	$5.00
4. Soil	texture (% sand, silt and clay)	enquire at lab	quoted on request
5. Soil	other analyses may be available for groups of over 20 samples	enquire at lab	
6. Liming materials	calcium and magnesium content, neutralizing value, particle size analysis	all times	$15.00
7. Dried plant and other organic materials**	nitrogen, phosphorus, potassium, calcium, and magnesium	all times	$11.00
8. Dried plant and other organic materials**	boron, copper, manganese and zinc	all times	$11.00
9. Dried plant and other organic materials**	9 elements listed in 7 and 8	all times	$14.00
10. Manure and other moist organic matter	nitrogen, phosphorus, potassium, calcium, and magnesium and % DM	all times	$13.00
11. Manure and other moist organic matter	boron, copper, manganese and zinc	all times	$13.00
12. Manure and other moist organic matter	9 elements listed in 10 and 11	all times	$16.00
13. Organic materials	sodium, iron, cadmium, chromium, lead, nickel, mercury and some other metals	enquire at lab	quoted on request

**Electrical conductivity.*

***Analysis of feed samples is arranged through the Department of Animal & Poultry Science.*

ONTARIO MINISTRY OF THE ENVIRONMENT PESTICIDES CONTROL FIELD OFFICES

Essex, Kent, Lambton	Box 237, 435 Grand Ave. W., Chatham, N7M 5K3	519-352-5107
Elgin, Middlesex, Oxford	985 Adelaide St. S., London, N6E 1V3	519-681-3600
Haldimand, Norfolk, Niagara, Hamilton, Wentworth	Ontario Government Building, 119 King St. W., Hamilton	416-521-7640
Brant, Dufferin, Wellington, Waterloo	Box 219, Clyde Rd., Cambridge, N1R 5W6	519-623-2080
Bruce, Grey, Huron, Perth	Box 688 Clinton, N0M 1L0	519-482-3428
Simcoe, Muskoka	12 Fairview Rd., Barrie, L4N 4P3	705-726-1730
Halton, Peel, York, Durham, Toronto	150 Ferrand Dr., 7th Floor, Don Mills, M3C 1H6	416-424 -3000 (ext. 204)
Peterborough, Victoria, Haliburton, Northumberland	139 George St., Peterborough, K9J 3G7	705-743-2972
Frontenac, Hastings, Lennox & Addington, Leeds, Prince Edward, Grenville	133 Dalton St., Box 890, Kingston K7Z 4X6	613-549-4000
Prescott and Russell, Renfrew, Stormont, Dundas and Glengarry, Ottawa-Carleton, Lanark	2378 Holly Lane, Suite 204, Ottawa, K1V 7P1	613-521-3450
Manitoulin, Nipissing, Parry Sound, Sudbury	1500 Fisher St., North Bay, P1B 2H3	705-476-1001
Algoma, Cochrane, Timiskaming	83 Algonquin Blvd. W., Timmins, P4N 4R4	705-264-9474
Kenora, Rainy River, Thunder Bay	Ontario Government Bldg., 435 James St. S., Thunder Bay, P7E 6E3	807-475-1305